

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested.

This Amendment is in response to the Office Action dated August 24, 2004.

By the present Amendment, claim 25 and its dependent claims have been amended to express the features previously defined in terms of means plus function language as a "wherein clause" instead. Although Applicants respectfully submit that the previous means plus function language was clearly supported by the Specification, in order to expedite the allowance of this application, this terminology has been changed to a "wherein clause" to obviate the 35 U.S.C. § 112, second paragraph, rejection. Therefore, removal of this rejection is respectfully requested.

The remarks which follow are directed to the various prior art rejections set forth in the Office Action. Following an initial review of the following remarks, it is requested that the Examiner contact the undersigned attorney to schedule an interview to discuss the rejections. Applicants and the undersigned attorney greatly appreciate the Examiner's courtesy and cooperation in this regard.

Independent Claims 17, 18, 20, 24 and 25

Reconsideration and allowance of independent claims 17, 18, 20, 24 and 25, and their respective dependent claims, over the cited prior art to Matsushita (JPA 53-10283), Okada (USP 5582640), VanDover (USP 6093944) and Lau is respectfully requested. With regard to this, each of the independent claims 17, 18, 20, 24 and 25 contains the specific recitations that:

"Compression strain is produced so that interatomic distances in the material are decreased to suppress leakage current from flowing through the gate insulators."

It is respectfully submitted that nothing in the primary reference to Matsushita, whether considered alone or in combination with the other cited prior art to Okada, VanDover and Lau, teaches or suggests these specific features.

In the first place, neither Matsushita nor any of the other cited references at all suggest use of compression strain in the recited gate insulating oxide materials (e.g., titanium oxide, zirconium oxide and hafnium oxide). Quite to the contrary, the primary reference merely provides a general statement of "less strains," It is respectfully submitted that "less strains" found in Matsushita gives no suggestion whatsoever of the claim limitation of "compression strain." Quite to the contrary, Matsushita's goal of providing less strain would actually have the ideal of zero strain. The term "less strains" could be either compression stain or tensile strain, and clearly both types of strain are sought to be minimized by Matsushita since he apparently equates such strain with the undesirable creation of crystal defects.

In effect, Matsushita's teaching of "less strains" actually teaches directly away from the present invention since less strain means an attempt to have no strain, whereas the present claimed invention deliberately introduces compressive strain to achieve the inventive purpose. For the Examiner's convenience, a partial translation of the Matsushita reference is provided herewith. A marked copy of Matsushita is also provided to correlate the partial translation portions with the actual Japanese text in Matsushita. As can be seen in the translated portions 1 and 3 of the attachment, the term "strain" is used, but no teaching whatsoever is found

concerning compression strain. In the translated portion 3, it is specifically stated that excellent electrical properties are provided, and:

"This seems to be derived from stability of the composition, less strains, no hygroscopicity and small content of charges of Na, K, etc."

As noted above, it is quite clear that Matsushita seeks to have as little strain as possible, whether it be compression strain or tensile strain.

To this end, it is clear that the intended purpose for Matsushita is to substantially eliminate strain to thereby eliminate defects. MPEP 2143.01 specifically provides a section headed "The Proposed Modification Cannot Render the Prior Art Unsatisfactory for its Intended Purpose." As set forth under this section of the MPEP:

"If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification."

It is respectfully submitted that this would be exactly the situation in the present instance since Matsushita seeks to substantially eliminate all strains, whereas the present claimed invention deliberately introduces compression strain for reduction of leakage current. In other words, the intended purpose of Matsushita (reduction or elimination of all strain) is directly opposite the intended purpose of the present invention (deliberate introduction of compression strain for reducing leakage current). As such, any modification of Matsushita to intentionally provide compression strain as is directly opposite Matsushita's intended purpose, and, accordingly, inappropriate.

The next distinguishing feature regarding the independent claims 17, 18, 20, 24, and 25 is the limitation that the interatomic distances are decreased to suppress

leakage current. In the Office Action, it is stated that this is "an inherent functional property," and, as such, is not given patentable weight. Applicants respectfully submit that this property is anything but inherent. In essence, a given body can have either no strain, tensile strain or compressive strain. Webster's New World Dictionary defines "inherent" as "existing in someone or something as a natural and inseparable quality, characteristic, or right; innate; basic; inborn." In other words, to be inherent is something that is a fundamental property, which cannot be separated from the material. Clearly, the fact that a given material might have compressive strain, no strain or tensile strain provides a situation where compressive strains is not inherent. Quite to the contrary of being inherent, strain is something which is introduced to the material either by an external force or a modification of the internal structure. Therefore, to provide the recited compression strain to decrease interatomic distances to suppress leakage current requires a deliberate modification of the material to achieve this compressive strain. It is respectfully submitted that this is clearly not "an inherent functional property" for the recited gate insulating materials.

It is recognized at the bottom of page 4 of the Office Action that:

"Matsushita does not specifically describe the newly added limitation so that interatomic distances are decreased to suppress leakage current from flowing through the gate insulators is an inherent functional property."

However, the Office Action goes on to cite the Okada reference as teaching the decrease of interatomic distances to control the shape and quality of recrystallized film. It is respectfully submitted that the teachings of Okada are not appropriate for modifying the Matsushita reference, and, even if the two references were combined,

the result would still not be the claimed invention set forth in the independent claims 17, 18, 20, 24 and 25, or their dependent claims.

In the first place, as noted above, Matsushita's attempt to provide less strains teaches directly away from the recited compression strain to reduce interatomic distances. Therefore, the attempt to modify Matsushita with the teaching of Okada would go directly against the intended purpose of Matsushita, which is prohibited by the above-noted teachings of MPEP 2141.01.

In the second place, the teachings of Okada with regard to interatomic distances are completely different than the purposes defined in the claims of the present invention. As noted above, independent claims 17, 18, 20, 214 and 25 each relate the reduction of interatomic distances to suppression of leakage current. This interrelationship between reduced interatomic distances and suppressed leakage current is completely unrecognized by Okada. Quite to the contrary, Okada seeks to control interatomic distances to attain low stress in crystallization by setting the average interatomic distance to be substantially equal to the average interatomic distance of the single crystal material (e.g., see column 13, lines 23-29 of Okada). For example, column 13, lines 37-55 teaches the control of the interatomic distances during crystallization to suppress stress. Although this may be of general interest, it is absolutely nothing to do with reducing the interatomic distance for suppressing leakage current, as required by each of the present independent claims 17, 18, 20, 24 and 25. Therefore, even if Matsushita could be modified with the teachings of Okada, the end result would be completely different than that defined by the present claims.

In addition to the above points, it is noted that the Matsushita reference teaches a gate insulating film thickness of 1,000 Å (e.g., 100 nm), as set forth in portion 2 of the attached partial English translation. It is noted that such a large thickness is quite unsuitable for a transistor in accordance with the present invention, which as much smaller thickness for the gate insulating film. This large thickness for the gate insulating film in Matsushita serves to make it even more inappropriate for the modification of Matsushita to introduce compressive strain for reducing leakage current.

As discussed above, the primary reference to Matsushita and the secondary reference to Okada completely fail to teach or suggest the essential features defined in each of the independent claims 17, 18, 20, 24 and 25. As such, nothing in the cited secondary reference to VanDover and Lau, which have been referred to primarily for features found in the dependent claims, makes up for the fundamental shortcomings of either of the references to Matsushita or Okada. Therefore, reconsideration and allowance of the independent claims 17, 18, 20, 24 and 25, together with their dependent claims, over the cited combination of references is respectfully requested.

Independent Claims 12, 19 and 22 and Their Dependent Claims.

Each of the independent claims 12, 19 and 22 defines its own distinguishing features over the cited prior art to Matsushita, Okada, VanDover and Lau discussed above. For example, independent claim 12 defines a combination of features of a channel region in a tensile strain arrangement with a titanium oxide gate insulator having an anatase main crystal structure to inhibit tunneling current caused by the

tensile strain. As such, a relationship is defined between tensile strain in the channel region and the main crystal structure of the titanium oxide as set forth in claim 12 which is completely unsuggested by the cited prior art. As discussed above, the goal of Matsushita is to eliminate strain as much as possible. The purpose of claim 12 is to provide a specific main crystal structure for a titanium oxide gate insulator to inhibit a rise in tunneling current caused by a tensile strain. In other words, the present claim 12 recognizes the existence of tensile strain in a channel region, and accounts for this appropriately with the specific crystal structure of the titanium oxide gate insulator. This concept of inhibiting an undesirable effect of tensile strain in a channel region is completely unrecognized and unsolved by any of the cited prior references.

Turning to independent claim 19, this teaches the titanium oxide having a rutile crystal structure and a specific relationship between the thermal expansion coefficient of the gate electrode being greater than the linear expansion coefficient of the titanium oxide gate insulator. Again, the cited references to Matsushita, Okada, VanDover and Lau completely fail to recognize this interrelationship between the material used for the titanium gate insulator (that is, having a rutile crystal structure) and the claimed relationship between the thermal expansion coefficient of the gate electrode and the linear expansion coefficients of the titanium oxide gate insulator. Therefore, it is respectfully submitted that claim 19 defines over the cited prior art.

Claim 22 defines a first MOS transistor having a gate insulator of high permittivity for high speed in conjunction with a second MOS transistor having a gate insulator of silicon oxide to resist high gate voltages. It is respectfully submitted that none of the cited prior art teaches or suggests this particular relationship between

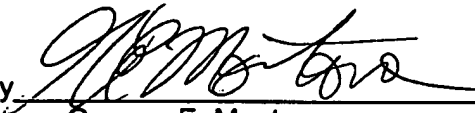
reconsideration and allowance of independent claim 22 and its dependent claim 23 is respectfully requested.

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of either by telephone discussion or by personal interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Antonelli, Terry, Stout & Kraus, LLP Deposit Account No. 01-2135 (Docket No. 500.41080X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By 
Gregory E. Montone
Reg. No. 28,141

GEM/dlt

1300 North Seventeenth Street, Suite 1800
Arlington, Virginia 22209
Telephone: (703) 312-6600
Facsimile: (703) 312-6666

Application No.: 10/043,099
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APPENDIX A